Current Topics

Census of Marine Life Reveals Abundant Diversity of Microbes

The International Census of Marine Microbes (ICoMM), part of the Census of Marine Life, uncovered a more diverse and larger population of microbes than was known or anticipated, according to principal investigator Mitch Sogin, director of the Josephine Bay Paul Center at the Marine Biological Laboratory in Woods Hole, Mass., and his collaborators there and at the Royal Netherlands Institute for Sea Research, Texel, the Netherlands. “The most important observation is that diversity is not just a few thousands of microorganisms,” he says. “It’s at least a half-million microbes, and maybe one or two magnitudes more.”

The ICoMM inventoried microbial numbers and diversity by cataloging all known single-cell organisms, including protists, bacteria, archaea, and associated viruses. The census confirmed that, by weight, up to 90% of marine life is microbial. Details appear in the First Census of Marine Life 2010: Highlights of a Decade of Discovery, which was released on 4 October.

The decade-long census project measured what lived or lives in oceans and assessed the health of this ecosystem. It sought to assess the diversity, distribution, and abundance of marine life, providing an overview that will help scientists more fully understand the planetary food chain and global processes such as the carbon cycle. The census also provides a baseline for developing ocean policies and research programs.

“The census project engaged thousands of scientists from all continents on hundreds of expeditions and invested hundreds of millions of dollars,” the report states, “using divers, nets, submersible vehicles, genetic identification, sonars, electronic and acoustic tagging, listening posts, and communicating satellites.” Researchers from more than 80 nations were involved, making the census one of the largest scientific collaborations ever undertaken.

The ICoMM determined that marine microbes are 10 to 100 times more diverse than expected. Researchers found that some marine microbes are ubiquitous in the ocean, while others have limited distributions. Much of the microbial diversity is due to rarely occurring microorganisms, according to Sogin. “Rare is common, not only for marine microbes but for many taxa and regions,” the report notes.

Microbial cells in the oceans number about $10^{29}$ and collectively weigh about as much as 240 billion African elephants, according to the report, which notes: “A single liter of seawater can contain more than 38,000 kinds of bacteria.” Despite this huge and mixed mass of microbiology, modern analytic technologies, particularly phylotyping via DNA sequencing, are adept at cataloguing that diversity. Indeed, scientists working on this project assembled 18 million

A tube core (8 cm diameter) collected from a Thioploca bacterial mat in the Peru-Chile oxygen minimum zone. The mat, approximately 1 cm thick (or 0.4 inches), consists of many individual filaments of giant bacteria. Each filament extends into the sediment and the water, sources of sulfide and nitrate, respectively. The mat covers nearly 130,000 square km of seafloor, equivalent to the land area of Greece. (Image courtesy of Lisa Levin, INSPIRE: Chile Margin 2010, NOAA-OER.)
DNA sequences of microbial life, spanning more than 100 major phyla. These numbers might be an underestimate; they do not fully account for parasites and other microbes that live within marine animals. Thus, the report notes, “up to 1 billion kinds of marine microbes may live in the oceans. Between 100 and 1,000 kinds of microbes may exist for each larger marine species.”

“From my perspective, the results are a veritable gold mine of data on the distributions of marine microorganisms in time and space,” says Jed Fuhrman, the McCulloch-Crosby Chair of Marine Biology at the University of Southern California in Los Angeles. He is part of an international research group whose members are analyzing the global diversity patterns embedded in the census data. They have barely scratched the surface so far, he says.

One early discovery from the census is the giant mat of microbes that lies off the central and northern coasts of Chile and Peru. One of the largest living structures ever identified, this mat covers nearly 130,000 square km of seafloor, equivalent to the land area of Greece. “The massive, diverse microbial community thriving mostly on methane-associated hydrogen sulfide probably represents a living fossil ecosystem of the Proterozoic era 2.5 billion to 650 million years ago, before and during the transition to an oxygenated atmosphere,” the report says about this mat off the coast of South America. “With so little oxygen, most multicelled life cannot survive. But microbes, such as the large multicellular filamentous ones making up the gigantic mats, can successfully thrive.”

Surprises were found outside the microbial realm of the marine environment. For instance, researchers identified a type of shrimp in Australia that was thought to have become extinct 50 million years ago. They also found the remains of cold-water corals stretching more than 400 km along the coast of Africa in 500-m-deep waters.

Despite their thoroughness, the researchers who completed the Census of Marine Life caution that its estimates of numbers and kinds of life in the oceans are not entirely reliable—in part because ICOMMM delved into relatively few marine environments. “The census raised more questions than it answered,” Sogin says. “Simple questions such as ‘Why are there so many kinds of organisms?’ It just points out how much more there is to learn.”

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House Bill Offers Incentives To Foster Antibiotic Development

A bipartisan group from the House of Representatives, led by Rep. Phil Gingrey (R-GA), who is a physician, last year introduced the “Generating Antibiotic Incentives Now Act of 2010,” HR 6331, which was assigned to the Committee on Energy and Commerce. The bill seeks to foster development of antibiotic drugs and diagnostic tests that are active against “qualifying pathogens,” namely a broad range of drug- and multidrug-resistant bacterial pathogens that are deemed a “significant threat to public health.” The legislation, if passed, would require federal officials to fast-track some antibiotics and also review Food and Drug Administration guidelines for clinical trials involving such candidate products, opening the possibility that those guidelines will be revised.

Boron-Containing Drug Candidates Effective vs. Sleeping Sickness Parasites

Novel boron-containing molecules prove effective killers of trypanosomes, the parasites that cause African trypanosomiasis, or sleeping sickness, according to Bakela Nare and Stephen Wring of Scynexis in Research Triangle Park, N.C., and their collaborators there, and at U.S. and Swiss universities as well as drug-development institutions in the United States and Switzerland. These oxaborole compounds, which belong to “the first new class of chemical showing activity in stage 2 African trypanosomiasis rodent models in a generation,” owe their effectiveness more to their pharmacokinetic tenacity for staying within the brain than to their direct potency against these parasites, Nare says. Details appear in the October 2010 Antimicrobial Agents and Chemotherapy (54:4379–4388).

(Editors’ note: During the 50th Interscience Conference on Antimicrobial Agents and Chemotherapy last September in Boston, researchers from GlaxoSmithKline in Collegeville, Pa., described boron-containing compounds with potent antibacterial activity; see Microbe, November 2010, p. 466.)

Some 60 million people living in sub-Saharan Africa, around 7% of Africans, are exposed to sleeping sickness, and nearly 250,000 die each year from the disease. The treatment regimen for sleeping sickness consists of two intravenously administered drugs, pentamidine and melarsoprol, that can be toxic for patients. The new candidate treatment appears far less toxic, and can be taken orally instead.